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(71) Applicant: MALOE GOSUDARSTVENE VNEDRENCHESKOE PREDPRIYATIE "POLITEKHENERGO"
St. Petersburg, 194100 (RU)

(72) Inventors:
- FINKER, Felix Zalmanovich
  S. Petersburg, 194018 (RU)
- AKHMEDOV, Javad Berovich
  S. Petersburg, 195257 (RU)
- KUBISHKIN, Igor Borisovich
  S. Petersburg, 189630 (RU)
- SOBCZUK, Czeslaw
  PL-Warszawa (PL)
- SWIRSKI, Jan
  PL-Warszawa (PL)
- GLAZMAN, Mark, Semenovich
  Columbus, OH 43209 (US)

(74) Representative: Glawe, Delfs, Moll & Partner
Patentanwälte
Liebherrstrasse 20
80538 München (DE)

(54) LOW-EMISSION VORTEX FURNACE

(57) The proposed low-emission vortex furnace is intended for use in burning organic fuel and can be used most effectively for burning dust. The proposed low-emission vortex furnace comprises a combustion chamber (1) with a cold prismatic funnel (5) which has a slit aperture, and a device (7) positioned underneath the funnel and used for introducing the bottom blast. The furnace contains at least one burner (2) in the form of at least two fuel-air mixture feed ducts (2a, 2b), one duct lying above the other. Each of the ducts (2a, 2b) is provided with a device (3, 4) for adjusting the fuel/air ratio; this device ensures that the ratio of air to fuel in the upper duct (2a) is always higher than in the lower duct (2b). The longitudinal axes of the ducts (2a, 2b) are advantageously inclined so that the angle between the longitudinal axis of the lower duct (2b) and the projection of that axis onto the furnace wall is less than in the case of the upper duct (2a). The furnace may also be provided with a device (8) for feeding fuel of a particular fractional composition into each duct. During operation of this furnace, three operational zones are formed in the furnace chamber, namely, an ignition and active combustion zone; a reduction zone; and a re-heating zone. This reduces the quantities of nitrogen oxides produced while ensuring that the furnace is highly economical to operate.

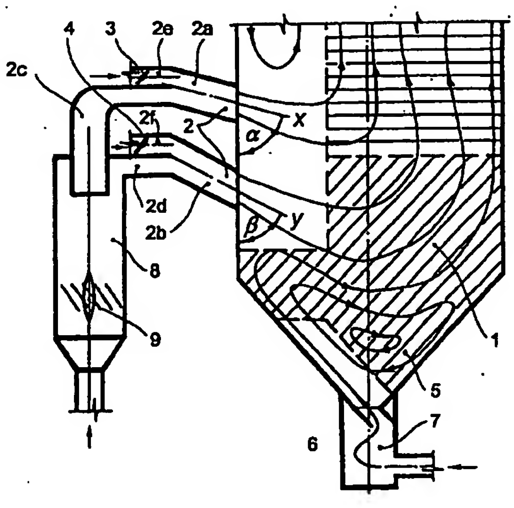

Fig. 1.

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Description

Field of the Invention

The invention relates to heat engineering and more particularly, to furnaces for burning organic fuel, and it can be most successfully used for burning powdered fuel.

Background of the Invention

When designing furnaces, a particular stress is laid on providing the complete combustion of the fuel, which is one of the determining factors for a more economical and environmentally oriented performance. The completeness of fuel combustion is known to be increased by a thorough intermixing of fuel and air and using a higher combustion temperature. An increased temperature in the burning zone, however, brings about an enhanced emission of nitrogen oxides due to formation of the so-called "thermal" nitrogen oxides as a result of air nitrogen oxidation. In addition, an increased flame temperature leads to slagging the heat-receiving furnace screens as well as to other negative results.

On the other hand, the reduction of the burning zone temperature by recirculating the combustion products, by a coarser grinding of the fuel, etc., will result in a less economical fuel combustion because of a sharp drop in the combustion reaction rate and consequently, a greater incompleteness of the fuel combustion.

The requirement for a complete fuel combustion also specifies the necessary amount of oxygen (air) supplied to the furnace. In order to burn a particular amount of fuel a strictly definite amount of oxygen is needed. In the case of its deficiency, incomplete burning of fuel occurs, with carbon monoxide formed in the process, with produces a detrimental effect on the environment. However, a considerable increase in the amount of air (oxygen) supplied is not desirable either, because in this case, there is an increased discharge into atmosphere of the excess air (oxygen) heated in the furnace, but not reacting with the fuel, which impairs the cost-effectiveness of the furnace and the entire boiler unit. Therefore, when designing the fuel combustion process, oxygen (air) is generally supplied with some excess.

In the majority of known solid fuel-fired furnaces, the excess-air coefficient is equel to 1.2, since this figure is most favourable in terms of cost-effectiveness. However, it is with such air (oxygen) excess that the maximum discharge of the fuel nitrogen oxides involved in oxidation of the nitrogen contained in the fuel is known to occur (cf. I.Ya.Sigal "Protection of Atmospheric Air from Contamination by Fuel Combustion Products", 1988, Nedra, Leningrad). The fuel nitrogen oxides are produced in the initial secton of the flame, where volatile components are released from the fuel (i.e. its thermal decomposition products).

According to present-day notions, a reduced nitrogen oxide concentration in the combustion products can be achieved by an optimized organization of three major zones in the flame, namely, zone of ignition and active combustion, zone of reduction, and zone of oxidation (reburning).

The ignition and active combustion zone is generally located in the vicinity of the burners. It is the bulk of the fuel that is ignited and burnt out in this zone. The reduction zone may be arranged in any part of the furnace chamber and is characterized by oxygen deficiency. Because of this, as the fuel interacts with the oxidizing agent (i.e. oxygen), partial combustion products (such as carbon monoxyde) are formed in this zone, which interact with other oxides, including nitrogen oxides, depriving them of oxygen and reducing to molecular nitrogen. The oxidation zone may be located in any region of the furnace, provided it contains excess oxygen. The incomplete fuel combustion products coming from other zones are further oxidized in this area, for example, transforming the harmful carbon monoxide into a reletively safe carbon dioxide.

Known in the art is a furnace (see G.N.Levit "Pulverization at Heat-Electric Generation Plants", 1991, Energoatomizdat (Moscow), p.132, Fig.7.2) comprising a vertical combustion chamber having burners for air-fuel mixture supply mounted on its walls. The burners are arranged in several tiers. The burners of each tier are connected with fuel preparation devices (mills) by means of pulverized-coal ducts, the burners of each individual tier being connected with a different mill, providing the air/fuel ratio control.

During operation of such furnace, the air-fuel mixture is supplied either through all of the burners or through part of them. The air/fuel ratio is chozen such that excess air is fed to the top-tier burners, and deficient air to the bottom-tier burners, resulting in an excess air coefficient of 1.2, which is the most economical value, as mentioned above. The bulk of the fuel is burnt within the ignition and active combustion zone adjacent the burners in the central portion of the combustion chamber. The combustion products rise up and are completely burned in the reburning zone, in the excess air supplied through the top-tier burners, and then carried away beyond the combustion chamber. Owing to the tier-wise arrangement of the burners, the combustion zone can be somewhat extended in the vertical plane, thereby increasing the fuel particle in-zone dwelling time and consequently ensuring more complete combustion of the fuel. In addition, a larger combustion zone leads to equalization of temperature fields within the zone and some reduction of the maximum combustion temperature, whereby the slagging of the furnace surface and formation of "air" nitrogen oxides (due to oxidation of air nitrogen at high temperatures) are prevented.

In such furnace, with the above arrangement of the burners, a certain optimization of the combustion zone locations and sizes can be achieved. So, for example, the size of the reduction zone in the furnace space is

increased, thereby extending the time needed for the partial combustion products [illegible]eract with nitrogen compounds, which has been s[illegible]o result in the reduction of nitrogen oxides. This is done by redistribution of "air-fuel" ratios between different burner tiers, in particular, so that a deficient amount of air is supplied to the bottom-tier burners to form the zone of reduction, while excess air is supplied to the top-tier burners to create a zone of reburning the partial combustion products. The small extention of the reburning zone causes a negligible oxidation of nitrogen.

As already mentioned above, with such arrangement of the burners the combustion zone temperature is somewhat reduced, leading to a sharp drop in the fuel burnout rate and consequently a lower output of the furnace. Fuerthermore, the relatively small size of the reburnng zone in such furnace fails to provide the required completeness of fuel combustion, thus impairing the economic performance of the furnace.

In order to maintain the cost-effective operation of the furnace under conditions of the aforementioned decrease in the fuel burnout rate, one has to reduce the fuel particle size, again resulting in a higher maximum combustion temperature, which will lead to a less efficient suppression of nitrogen oxide generation and hence, to a greater probability of slagging the furnace surfaces.

There is another way of making up for a decrease in the fuel burning rate, while maintaining relatively low maximum combustion temperatures, namely: by extending the particle dwell time in the zones of active combustion and reduction This aim is attained in swirling-type furnaces.

Known in the art a furnace (SU, A, 483559) comprising a combustion chamber with an air-fuel mixture supply burner mounted on its wall. The wall slopes of the lower part of the combustion chamber are made to define a V-type dry-bottom ash hopper with a slot-like mouth. Below the dry-bottom hopper is disposed an udergrate blast device such as an air nozzle.

During operation of such furnace, the air-fuel mixture is supplied through the burner, and air is fed from below, through the slot-like mouth, using the udergrate blast device. As a result of interaction between two opposite streams, a swirl zone is formed in the bottom part of the furnace and a direct-flow zone in the top part thereof. The fine particles of the fuel burn in the area adjacent the burners and in the direct-flow zone, while the medium-sized and course particles are separated into the swirl zone. In the swirl zone, these particles are burnt out in the process of recycling. After burning out down to a definite size, they are carried away from the swirl zone and completely burned in the upper, i.e. direct-flow, part of the flame. An intense intrafurnace recirculation of the "air-combustion products-fuel" mixture results in a substantial decrease and equalization of temperatures throughout the swirl zone. To prevent the bulk of the particles from burning in the vicinity of the burners and to benefit most from the swirling-type furnaces, a variety of techniqu[illegible] employed in such furnaces, for example, the us[illegible] coarser particle-sized fuel with the relatevely lo[illegible]e-particle content, the downward tilting of the burners and increasing the airflow rate therein for better separation of the fuel particles off to the swirl zone. The reduced fuel combustion rate caused by lower maximum combustion temperatures and by the larger-sized fuel particles is balanced out by an extended time of the fuel dwelling within the low-temperature area, i.e. in the swirl zone. At the same time, a substantial part of the swirl zone is occupied by the zone of reduction known for its deficiency in oxygen. This enables the disgarge of nitrogen oxides to be minimized, as a result of their reduction.

The field tests of a boiler incorporating such furnace have confirmed a substencial decrease in the temperature level and a sharp drop in the nitrogen oxide concentration in the exit gases. In such furnace, however, as mentioned hereinbefore, the bulk of the burning fuel circulates within the swirl zone, whereas in the direct-flow zone containing excess oxygen and acting as a reburning zone, the temperature proves to be still lower than in the swirl zone, because of the small quantity of the burning fuel. Therefore, the fuel particles carried away from the swirl zone, largely, have not time enough to burn out in the direct flow portion of the flame. The heat losses due to mechanical incompleteness of fuel combustion in such furnace are generally above the normative values, resulting in a comparatively poor cost-effectiveness of the furnace.

Disclosure of the Invention

It is the object of the present invention to provide a swirling-type furnace such that it allows a repeated circulation of fuel particles in the low-temperature reduction zone and simulteneous reburning of fine-grained coke particles in the high-temperature oxygenated zone, thereby reducing the discharge of nitrogen oxides and resulting in a more cost-effective furnace.

With this object in view, in a swirling-type furnace comprising a combustion chamber with at least one downward-titled air-fuel mixture supply burner mounted on its wall, a prism-shaped dry-bottom hopper having a slot-like mouth defined by the wall slopes of the bottom part of the combustion chamber, and an undergrate blast inlet device located below the dry-bottom hopper mouth, according to the invention, the width of the outlet nozzle of the undergrate blast device is equal to that of the dry-bottom hopper slot-like mouth, the burner is formed by at least two ducts for air-fuel mixture supply, lying one above other, and each of the ducts is provided with a device for controlling the air/fuel ratio, said devices being so designed that the air-to-fuel ratio in the upper duct invariably exceeds that of the lower duct.

During operaton of such furnace, an air-fuel mixture is supplied through both of the burner ducts, and air is supplied from beneath, through the undergrate blast inlet, over the entire width of the dry-bottom hopper

mouth. Because each of ducts is provided with a means for controlling the air/fuel ratio, and the means ensure the above air-to-fuel ratio in each of the ducts, an excessive amount of oxygen finds its way to the upper portion of the combustion chamber, when this zone is sufficiently loaded with fuel particles coming from the overlying burner duct, causing thereby a relatively high combustion temperature with excess oxygen in this zone and consequently, an efficient fuel reburning. The charging of fuel into the middle portion of the furnace is preferably done from the underlying duct with a deficient amount of oxygen.

As a result of interaction between the air-fuel mixture flow out of the duct and the air fed from the undergrate blast inlet means across the width of the dry-bottom hopper mouth, a swirl zone is created, whose major part is characterized by an oxygen deficiency and a relatively low maximum temperature, serving as the reduction zone, and the peripheral part which is adjacent the wall receiving the undergrate blast air shows an excess of oxygen and serves as the oxidation zone.

By virtue of recirculation, the bulk of medium-sized fuel particles are burnt in the swirl zone, a nitrogen-oxide reduction process simulteneously occuring in this zone because of the oxygen deficiency. The large-sized fuel particles from both of the burner ducts are separated into the lower part of the furnace, picked up by the ascening air current and carried again into the swirl zone near the burner, and so forth, until the fuel particles are completely burnt out.

The burner ducts are preferably so arranged that the angle formed by the longitudinal axis of any duct and the projection of this axis on to the respective wall of the combustion chamber is less, than the corresponding angle for the overlying duct. With the ducts so inclined relative to the wall, there is provided a vertical extension of the reduction zone and consequently, a longer time for the burning particles to stay in the low-temperature zone, resulting in a more complete combustion of the fuel and reduction of nitrogen oxides. Further, it permits a vertical separation of the zones performing different functions, i.e. the reduction and the oxidation zone, enabling the air/fuel ratio for each duct to be selected more accurately, in order to provide the optimized modes of furnace operation. In addition, such sloping of the burner ducts provides a still more effective charging of the fuel into both the upper and the central part of the combustion chamber and hence, a higher fuenace output.

It is preffered that the furnace be provided with a means, such as the dust concentrator, for supplying the fuel of a specified size composition to each of the ducts. In this case, a predominantly fine-grained fuel should be fed to the overlying duct so that it has time to burn in the neigbourhood of this duct, ensuring the required temperature level, whereas the underlying duct should receive a coarser-grained fuel which burns succesfully in the swirl zone.

Brief Description of the Drawing

The invention is further illustrated by a detailed description of its preffered embodiment with reference to the accompanying drawing in which:

Fig.1 is a longitudinal section of a swirling-type furnace, according to the invention.

Preffered Embodiment of the Invention

Reffering to Fig.1, the swirling-type furnace, according to the invention, comprises an upright combustion chamber 1 with a burner 2 for air-fuel mixture supply mounted on its front wall. The burner 2 is formed by a pair of ducts 2a and 2b for supplying the fuel-air mixture. The duct 2a includes a branch pipe 2c, and the duct 2b a branch pipe 2d for supplying the mixture. Further, the duct 2a includes a branch pipe 2e, and the duct 2b a branch pipe 2f for air supply. In order to control the air/fuel ratio, each of the branch pipes 2e, 2f is provided with a device formed by, say, gates 3 and 4 fitted in the branch pipes 2e, 2f, respectively. In addition, the cross-sectional areas of the branch pipes 2c and 2d and of the branch pipes 2e and 2f, as well as the controlling range for the gates 3 and 4, are chosen such that in any position of the last-named components, the air-to-fuel ratio for the duct 2a exceeds that for the duct 2b. The furnace of the invention may also include a larger number of ducts. In this case, their mechanical design is similar to that described above. Both the front and the rear wall of the combustion chamber are inclined at bottom end and combine with thw side walls to form a prismatic dry-bottom hopper 5 with a slot-like mouth 6. Disposed beneath the mouth 6 of the dry-bottom hopper 5 is an udergrate blast inlet means 7. As shown in Fig. 1, the angle α made by the longitudinal axis X of the duct 2a with the projection of this longitudinal axis X on to the wall of the combustion chamber 1 is greater than the angle β made by the longitudinal axis Y of the duct 2b with the projection of this axis on to the wall of the combustion chamber 1. It will be noted that the "fuel" nitrogen oxides are largely produced in the initial portion of the flame. Therefore, depending on the kind of fuel and the features of the specific furnaces, the mutual arrangement of the duct axes must be such as to allow separation, across the height, of the zones with different functions - reduction and oxidation - and to make the choice of the air-fuel ratio for each of the ducts as precise as possible. The air-fuel mixture flows coming out of the ducts 2a and 2b diverge, as they move away from the mouths. The aperture is generally about 7 degrees. Therefore, for most of the fuels and furnace chamber types employed, the angles between the longitudinal axes of the ducts 2a and 2b are generally from 12 to 15 degrees. The furnace is also equipped with a device for supplying the fuel of a specified size composition to each duct, which device is implemented in the form of a dust concentrator 8 with a swirler 9. Any concentrator

out of those generally employed in heat engineering may be used here, as well[illegible]her known devices intended for the purpose. Th[illegible] of a specified size composition may also be supplied to each duct by means of mills, as was the case in the aforementioned known device.

The operating of the swirling-type furnace now follows.

An air-fuel mixture is supplied to the dust-concentrator 8. The swirler 9 swirls the stream, causing the fuel to be size-separated by a centrifugal force,namely: the coarser fuel particles are forced against the walls of the dust concentrator 8 and are fed, largely, to the branch pipe 2d, while the finer (less inertial) particles of the fuel are raised along with the air current and received by the branch pipe 2c. So the relatevely finer fuel particles are fed to the upper duct 2a and the relatively coarser fuel particles to the lower duct 2b. The amounts of the fuel supplied to the upper and lower ducts are dependent on the dust concentrator design and are preset according to the type of fuel and the boiler furnace chamber design. The amount of fine-grained fuel supplied to the upper duct must be such as to provide the required temperature level in the vicinity of the upper duct. At the same time, air is supplied through the branch pipes 2e and 2f, controlling its flow rate by means of the gates 3 and 4, respectively, so that more air is supplied to the upper duct 2a and less to the lower duct 2b. In addition, air is supplied simulteneously by the undergrate blast means 7 through the slot mouth 6. As a result of interaction between the air-fuel mixture flows coming to the furnace from the ducts 2a and 2b and the counterflow from the undergrate blast means, a vortex gas flow is generated in the lower part of the furnace. The air-fuel mixture flows coming from the ducts 2a and 2b diverge, as they move away from the mouths of the ducts, expanding and filling the heating space with the fuel mixture.

By virtue of the longitudinal axes of the ducts 2a and 2b being inclined at different angles to the walls of the combustion chamber 1,the angle α of slope of the longitudinal axis X of the duct 2a exceeding the angle β of slope of the longitudinal axis Y of te duct 2b, practically the whole furnace volume of the combustion chamber is filled with the fuel mixture uniformly over the height thereof. If the furnace accommodates a larger number of ducts, a still more effective filling of the heating space with the air-fuel mixture is possible. Relatively finer fuel particles are burnt near the mouth of the ducts 2a and 2b. It is in this region that the ignition and active combustion zone is generated. The bulk of the finer fuel particles are ignited and burnt just in this zone.

In Fig.1, the ignition and active combustion zone is shown unatched. Adjacent the upper duct 2a, with excess oxygen supplied through the branch pipe 2e, the combustion takes place at the comparatively high temperature, the "fuel" nitrogen oxides being produced in the process. However, as the smaller portion is supplied through this duct, the amount of resulting nitrogen oxides is rather insignificant. On the other hand, the larger portion of the fuel enters the furnace through the duct 2b, part of the fuel, [illegible], the finest particles, being burnt near the burner[illegible]the ignition and active combustion zone there existing.

The functioning of this zone is maintained both by the small quantity of air supplied from the duct 2b and by the undergrate blast air supplied through the slot mouth of the dry bottom hopper, along the slope, to find its way under the duct 2b. The remaining (unburnt) fuel is separated into the swirl zone in the central part of the furnace, and as the slope β of the longitudinal axus Y of the lower duct is smaller than the slope α of the X axis of the upper duct, the swirl zone proves to be very much extended in a vertical plane. This results in a reduced maximum combustion temperature, equalized temperature fields and a vast reduction zone generated under oxygen deficiency conditions.

In addition to providing the necessary amount of oxygen in the furnace volume, the undergrate blast device performs another important function: return into the swirl zone of all the fuel particles that had been separated into the lower part of the furnace chamber. This is done by providing that the outlet nozzle of the undergrate blast device is equal in width to the slot mouth 6 of the dry-bottom hopper 5, thus preventing the fall-through of some fuel particles. These factors are largely responsible for the resultant high economic and environmental performance of the furnace.

In Fig.1, the reduction zone is indicated by slanted hatchas. When the fuel is burnt with oxygen deficiency and at relatively low temperatures, thare is produced a certain amount of nitrogen oxides and incomplete combustion products. However, because of the presence of a vortex flow and a relatively large-sized reduction zone, and as these products stay in the reduction zone for a long time, the incomplete combustion products, such as carbon oxides, intreact with other oxides, such as nitrogen oxides.

As a consequence, the carbon monoxide takes up oxygen from the nitrogen oxide, reducing it to molecular nitrogen. At the same time, the poisonous carbon monoxide is changed to a relatively harmless dioxide. The unburnt fuel particles left over after the reduction zone are predominantly carbon (coke) particles that are essentially nitrogen-free.

Coke and gaseous products of incomplete combustion at the outlet from the swirl zone are introduced into the air-fuel mixture flow from the upper duct which exhibits an excess air content and creates the reburning zone indicated in Fig.1 by a horizontally hatched area. Since, as it was mentioned hereinbefore, the reburning zone receives from the overlying duct the amount of fine-grained fuel which provides, in the process of combustion, a high temperature in this zone, a relatevely complete reburning of solid and gaseous partial-combustion products occurs.

In case the furnace includes more ducts than the above design, a still more efficient fillings of the heating volume with the air-fuel mixture can be achieved, pro-

viding a more complete fuel combustion.

Thus, among the distinctive features of the proposed furnase is recirculation of fuel particles in the low-temperature reduction zone and simulteneous reburning of fine-grained particles carried away from the swirl zone in the high-tempreture, oxygenated, zone. This causes a reduced discharge of nitrigen oxides. At the same time, owing to a vortex flow present in the furnace, and by making the outlet window of the undergrate blast device as wide as the mouth of the dry-bottom hopper, a relatively complete combustion of the fuel is ensured, with the consequent cost-effectiveness of the furnace.

Industrial Application

The proposed invention was implemented in an attempt to modernize the furnace of an industrial boiler using coal dust as the fuel. The furnace had four burners, one on each wall thereof. The burners each are formed by a pair of ducts lying one above the other. The angle made by the longitudinal axis of the upper duct of each burner with the projection of this axis on to the vertical wall of the combustion chamber was 75 deg., and the angle made by the longitudinal axis of the lower duct of each burner with the projection of this axis on to the vertical wall of the combustion chamber was 55 deg. Fuel characterized by a sieve residue of 200 µm R_{200} = 3...5% was supplied to the upper ducts, whereas to the lower ducts was supplied fuel with a sieve residue of 200 µm R_{200} = 20...25 %. After modernization, the amount of nitrogen discharged was reduced by 35...40 %.

Claims

1. A low-emission swirling-type furnace comprising a combustion chamber (1) with at least one downward-titled burner (2) for supplying the air-fuel mixture, with a prismatic dry-bottom hopper (5) having a slot-like mouth (6) defined by the slopes of the walls of the bottom part of the combustion chamber (1) and an undergrate blast inlet means (7) disposed beneath the mouth (6) of the dry-bottom hopper (5), **characterized** in that the burner (2) is formed by at least two ducts (2a, 2b) for supplying the air-fuel mixture, lying one above the other, each of the ducts (2a, 2b) being provided with a device (3, 4) for controlling the "air/fuel" ratio, said device (3, 4) being chosen such that the ratio between the amount of air and the amount of fuel for the overlying duct (2a) proves to be invariably higher than that for the underlying duct (2b).

2. A low-emission swirling-type furnace as claimed in Claim 1,
characterized in that the angle between the longitudinal axis of any of the ducts and the projection of this axis on to the respective wall of the combustion chamber is less than the corresponding angle of the overlying duct.

3. A low-emission swirling-type furnace as claimed in Claims 1 or 2,
characterized in that the furnace is further provided with a means (8) for supplying th fuel of a specified size composition into each duct.

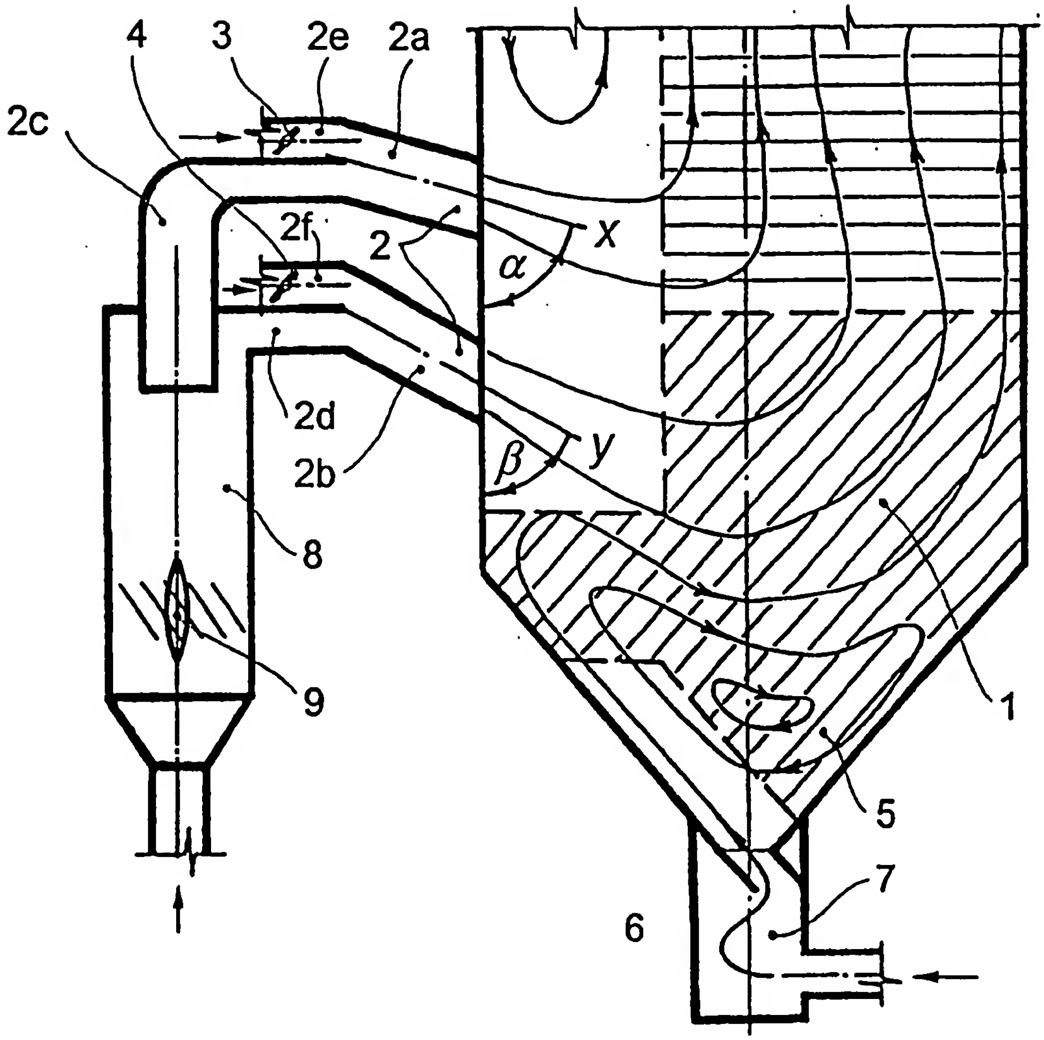

Fig. 1.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 95/00282

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.6 F23C 5/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl.6 F23C 5/24, 5/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	V.P. Kotler,"Spetsialnye topki ehnergetidieskikh kotlov" 1990. "Ehnergoatonizdat", (Moskva), pages 53-55, figs. 26-28	1 - 3
A	WO, A1, 94/14004 (CHAMIN V.A.), 23 June 1994 (23.06.94)	1 - 3
A	SU, A, 987286 (LENINGRADSKIJ POLITEKHNICHESKIJ INSTITUT 7 January 1983 (07.01.84)	1 - 3
A	SU, A, 1089354 (MOSKOVKIJ EHNERGETICHESKIJ INSTITUT), 30 April 1984 (30.04.84)	1 - 3
A	SU, A1, 1460534 (SIBIRSKIJ FILIAL USESOYUZNOGO TEPLOTEKH-NICHESROGO NAUCHNO-ISSLEDOVATELSKOGO INSTITUTA I MOSKOVSKIJ EHNERGETICHESKIJ INSTITUT), 23 February 1989 (23.02.89)	1 - 3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
26 April 1996 (26.04.96)	15 May 1996 (15.05.96)
Name and mailing address of the ISA/ RU Facsimile No.	Authorized officer Telephone No.

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